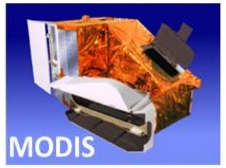
Discussion - Path Forward for Multi-instrument L1 Data Records

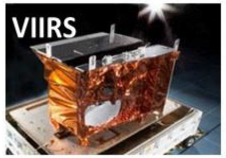
Jim Gleason

Suomi NPP Project Scientist

JPSS Senior Project Scientist

Opinions presented here are my own!





1999 →

2002 →

2011 →

2017 →


10/22 JPSS-2


12/27 JPSS-3


12/32 JPSS-4

Goal - Answer Critical Earth Science Questions with Long-term Satellite Data

- **Required: Long-term multi-instrument data products with well-characterized errors**
  - **Level 1 data from each instrument with quantified inter-instrument calibrations**
- **Background**
  – Sufficient on-orbit characterization of multiple instruments, e.g. MODIS (Aqua) and VIIRS (S-NPP and N-20).
  – Calibration differences between instruments (and matching band pairs) identified by different groups and disciplines.
  – Similar issues to be encountered for future VIIRS instruments (J2/J3/J4) and other imaging radiometers.
- **Objective for today**
  – A path forward for multi-instrument L1 data records that is agreed upon by individual groups and disciplines.
    – Who: groups, people, ..
    – What: Plan, sample data,
    – When: Timeline for path and production

Discussion - Path Forward for Multi-instrument L1 Data Records

- **Options**
  1. All data products should use a single unified L1 data set with adjustments made to the band offsets determined by some TBD L2 data product band offset analyses.
  2. Continue to have instrument calibration teams do the best job on each individual instrument and let the L2 product developers determine and correct their own offsets between instruments and interested band pairs. This option should be made by decision, not by default.
  3. A hybrid approach – On top of a single unified L1 data set (option 1), individual L2 product developers to apply correction, on as need basis, for the remaining (small) offsets

Discussion - Path Forward for Multi-instrument L1 Data Records

Feedback: Rob Levy
I vote for the effort of #1. If it turns out to be impossible, then each team is always free to make their own adjustments.

If we have any chance at stitching Earth system climate data records from the union of our products (land, sea, fire, ice, atmosphere), then I believe we have to aim toward #1.   I would even suggest even a few more steps including :

Best understandings of input spectral solar irradiance (E0) and as function of time
Best understanding of In-band versus out-of-band responses
Everything that influences how we interpret the "reflectance" and "radiance" we use in our retrievals and analyses.

Note that #1 shouldn't be limited to the sensors in A33/A52, I would advocate for including other sensors as well. Or at least develop the infrastructure for #1, starting with A33/A52 and make room to grow.
One more question, what happened to Terra? Would it not be included in this exercise?

Comments: Decide on the methodology
Start with the easiest case;
Is Afternoon only the easiest?
Afternoon moderate resolution imagers
Aqua MODIS, SNPP VIIRS, NOAA-20 VIIRS, … J2/3/4

Discussion - Path Forward for Multi-instrument L1 Data Records

Feedback: Kevin Turpie. *concur with Rob comments and his question.*
I. What does instrument agreement mean exactly when all relevant instrument behaviors are considered (e.g., radiometric response, temperature response, in-band and OOB response, polarization response, stray light rejection, ...).

II. What do we ultimately want to be inter-consistent? (e.g., TOA radiometry? Surface reflectance? Targeting the in-band region or normalizing to the band center or a common wavelength?)
… In principle, yes, we should want to have all instruments "agree" when measuring a common target from orbit and I totally support that efforts that take us in that direction, so ***I also vote for #1****.*

(OTH) *But, is that sufficient? Many of our data products depend on surface measurements, which still need to fall under the L2 teams. Accounting for instrument effects are inextricably entangled in the L2 algorithms. … our ultimate objective should be to achieve consistent surface radiometry across sensors and that must remain a responsibility of the L2 teams. …*

In short, ***I also vote for an augmented #2****, where Jack's team continues to do the best that they can, including undertaking #1, and the L2 teams work with them to best understand instrument effects and achieve inter-consistent surface measurements across instruments with improved L2 algorithms.*

Comments: The goal; Answering Science questions with data products with well characterized errors.
Consistent Radiometry is a step towards the goal

Do we need them to agree or just quantify how they are different?

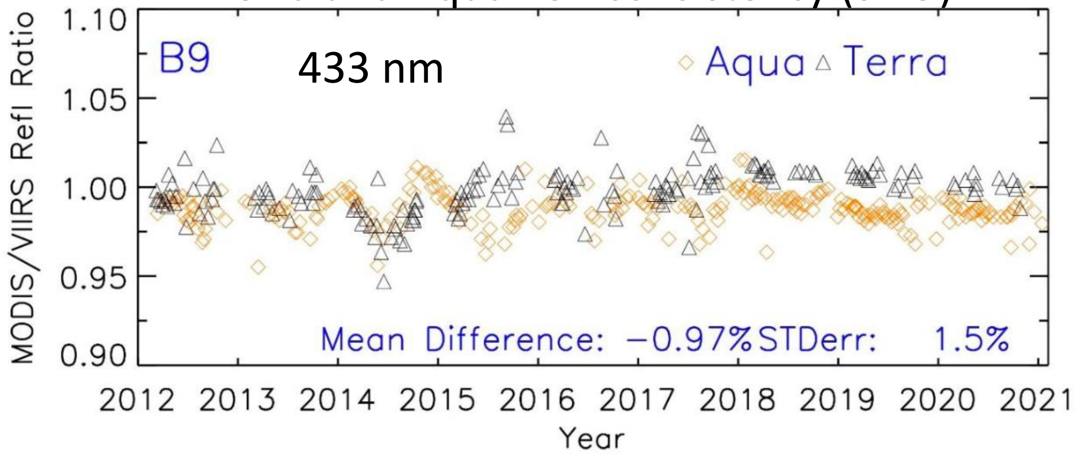
What we have seen at this Meeting

Jim's quick takeaways from chart review

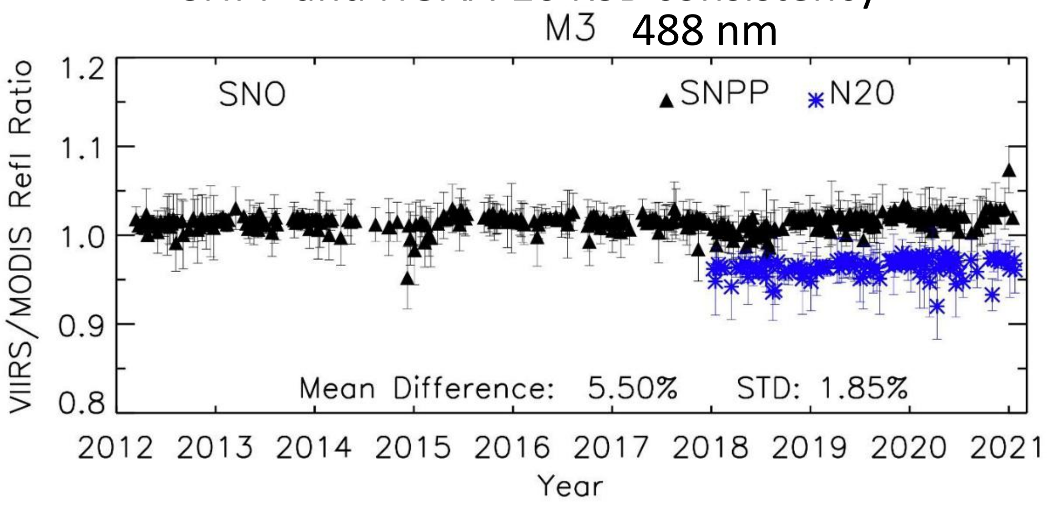
MODIS and VIIRS Calibration Inter-comparisons (Aisheng Wu)

Quantitative RSB Comparisons between MODIS and VIIS based on surface observations

Terra and Aqua RSB consistency (SNO)



SNPP and NOAA-20 RSB consistency



Calibration of SNPP and NOAA-20 VIIRS for Ocean Color Applications (Gene Eplee)

See chart 21 J1/SNPP ratios by 4 methods in good agreement

JPSS1 RRS are more stable over time than SNPP RRS

MODIS and VIIRS Calibration/Validation Results Using RadCaTS (Jeffrey Czapla-Myers)

Terra & Aqua MODIS, SNPP and NOAA-20 VIIRS radiometric calibration agree with RadCaTS to within uncertainties, except for NOAA-20 Band M11 (2.3 µm)

What we have seen at this Meeting

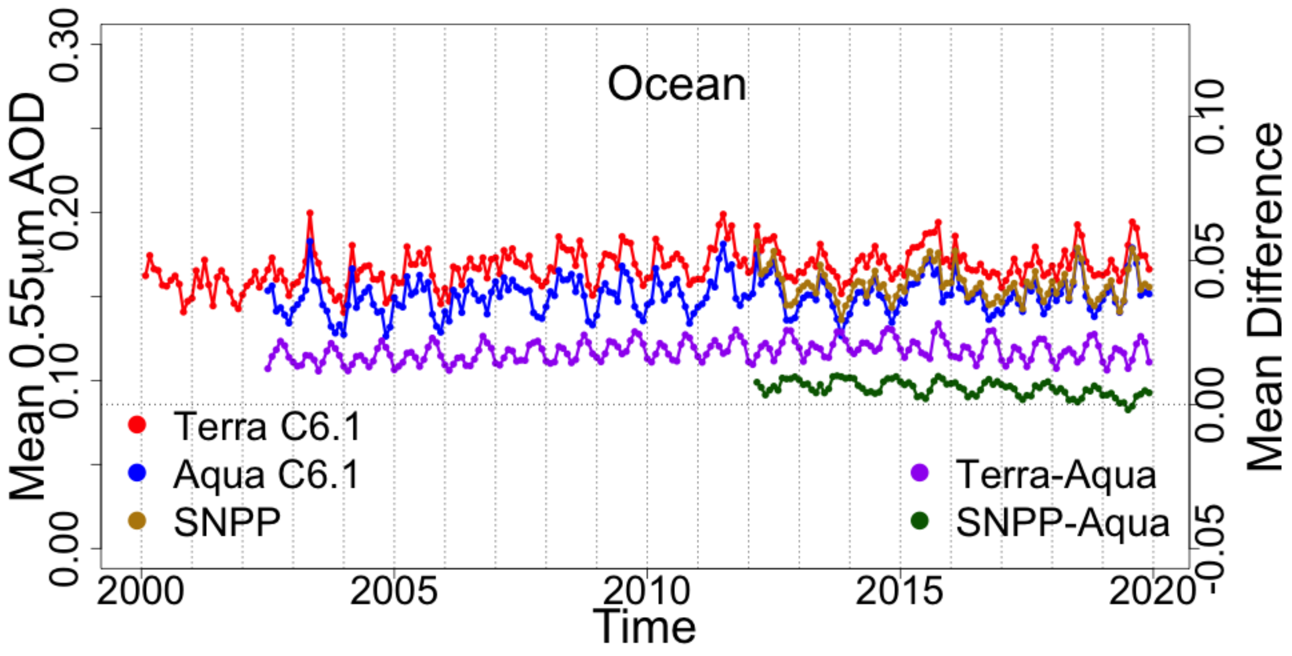
Jim’s quick takeaways from chart review

Trends and continuity in the AOD record for MODIS, VIIRS, and GEO sensors (Virginia Sawyer)

Adding VIIRS SNPP to the Climate Data Record
•Dark Target ported to SNPP VIIRS

Terra and Aqua disagree on whether particle size is changing, particularly in the SH ocean
Terra sees an increase in fine mode aerosol, but Aqua sees no significant change
Terra-Aqua offsets can vary by wavelength, which affects Ångström exponent and any other measure that compares multiple bands

Ångström exponent difference caused by instrument difference?



Upcoming VIIRS NOAA-20 product will further extend the AOD satellite climate data record, but will also come with its own offsets

Which one is “true”?

Users who need a single unbroken data record may choose to transition from Aqua to NOAA-20, and adjust the others to match

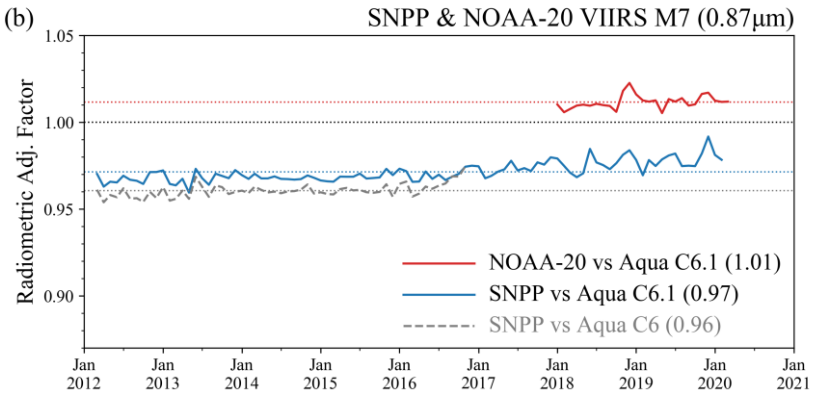
What we have seen at this Meeting

Jim's quick takeaways from chart review

SNPP/NOAA20 VIIRS Continuity with MODIS, Evaluation from Land Surface Reflectance Perspective (Eric Vermote)
Long-term Red/Green ratio comparisons. God agreement between Aqua and SNPP in green, use as spectral tie point?

MODIS-VIIRS inter-sensor shortwave radiometric monitoring by the Cloud Product team and the A-SIPS (Kerry Meyer/Bob Holz)

VIIRS Wavelength (Band Designation)			0.67 µm (M5)	0.87 µm (M7)	1.24 µm (M8)	1.61 µm (M10)	2.25 µm (M11)
Radiometric Adjustment Factor	NOAA-20	vs MODIS C6.1	1.0	1.01	1.02	1.02	0.99
	SNPP	vs MODIS C6.1	0.95	0.97	0.99	0.98	0.97
		vs MODIS C6	0.94	0.96	0.98	0.98	0.97
		Deep Blue Gain Factors	*0.941*	*0.963*	*1.011*	*0.981*	*0.931*



Open Access Article

Derivation of Shortwave Radiometric Adjustments for SNPP and NOAA-20 VIIRS for the NASA MODIS-VIIRS Continuity Cloud Products

by Kerry Meyer [1,*], Steven Platnick [1], Robert Holz [2], Steve Dutcher [2], Greg Quinn [2] and Fred Nagle [2]

[1] Earth Sciences Division, NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA
[2] Space Science and Engineering Center, University of Wisconsin, Madison, WI 53706, USA
[*] Author to whom correspondence should be addressed.

Remote Sens. 2020, *12*(24), 4096; https://doi.org/10.3390/rs12244096

Received: 9 November 2020 / Revised: 2 December 2020 / Accepted: 14 December 2020 / Published: 15 December 2020

(This article belongs to the Special Issue Analysis of Decadal-Scale Continuous Data Products from Weather Satellite Platforms)

View Full-Text | Download PDF | Browse Figures | Cite This Paper

Deep Blue;
Cross-calibration of S-NPP VIIRS moderate-resolution reflective solar bands against MODIS Aqua over dark water scenes
Sawyer, et al
Atmos. Meas. Tech., 10, 1425–1444, 2017
https://doi.org/10.5194/amt-10-1425-2017

What we have seen at this Meeting

Jim's quick takeaways from chart review

How do these adjustments compare with the MCST/VCST SNO comparisons shown yesterday?

VIIRS Wavelength (Band Designation)		M5	M7	M8	M10
Cloud Team Radiometric Adjustment Differences	Aqua MODIS – NOAA-20	0.0	1.0	2.0	-1.0
	SNPP – NOAA-20	5.0	4.0	3.0	4.0
MCST/VCST SNO Radiometric Differences	Aqua MODIS – NOAA-20	5.1	2.8	-0.5	1.2
	SNPP – NOAA-20	4.7	2.9	2.7	2.6

Notes: MCST/VCST differences are from Aisheng Wu's slides yesterday. Cloud Team radiometric adjustment differences are simple arithmetic calculations from the adjustment factor table on the previous slide – exact magnitude may be off slightly.

Upshot: The SNPP – NOAA-20 differences generally agree, but the Aqua MODIS – NOAA-20 differences do not.

Caveat: Need to verify consistency in VIIRS L1B versions used by the two teams.

Path Forward

For Discussion:

Form multi-discipline committee

From Cloud, Aerosol, Ocean, Land & VCST

Provide recommendation for:

Time dependent Calibration per instrument

Band offsets for individual bands per instrument

Provide "best" common data set.

Allow for data product/discipline tuning on calibration

Provide common library/archive of adjustment factors

Enable insight across multiple disciplines

What we have seen at this Meeting

Jim's quick takeaways from chart review

Clouds offsets vs Vicarious Calibration Result

VIIRS Wavelength (Band Designation)			0.67 µm (M5)	0.87 µm (M7)	1.24 µm (M8)	1.61 µm (M10)	2.25 µm (M11)
Radiometric Adjustment Factor	NOAA-20	vs MODIS C6.1	1.0	1.01	1.02	1.02	0.99
	SNPP	vs MODIS C6.1	0.95	0.97	0.99	0.98	0.97
		vs MODIS C6	0.94	0.96	0.98	0.98	0.97
		Deep Blue Gain Factors	*0.941*	*0.963*	*1.011*	*0.981*	*0.931*

From VCST Vicarious Cal
Wu et al this meeting
Aqua and NOAA20 RSB comparison (Aqua –N20) (%)

Method	B1/M5 0.65	B2/M7 0.41	B5/M8 0.55	B6/M10 0.67
SNO	5.1 (1.5)	2.8 (1.7)	-0.5 (0.9)	1.2 (2.0)
Desert	4.3 (0.7)	0.7 (0.6)	2.9 (0.9)	-1.4 (0.7)
Dome C	3.7 (1.8)	0.6 (1.8)	n/a	n/a
DCC	2.6 (1.5)	n/a	-1.4 (0.9)	0.4 (2.6)